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Description of the Nebula about the Star θ Orionis.

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(*Read before the Academy, April 3, 1848.*)

THE nebula surrounding the star θ Orionis was first seen, figured, and described by Huygens in 1659. During nearly two hundred years it has continued to excite the interest of astronomers, while every successive improvement in the telescope has developed some new and remarkable feature.

It was the first object to which Sir William Herschel directed his noble forty-foot reflector, in 1787, and it subsequently engaged much of his attention. To his distinguished son we are indebted for the first delineation which could be called even an approximation to its true figure.

The drawings and the description of this nebula, which Sir John Herschel has given to the public in the second volume of the Memoirs of the Royal Astronomical Society of London, were founded principally upon observations made with his twenty-foot reflectors during the years 1824–26. Every one joined with him, at that time, in the opinion that he had given a sufficiently accurate representation to serve as a standard of comparison for subsequent observers in regard to change of form or condition.

The utmost care and skill had been devoted to the work, in order to locate the stars justly, and to give all the different degrees of intensity and convolutions of the light with precision and delicacy. Nevertheless, the first glance which Sir John Herschel obtained of it under the more favorable auspices for observation which he enjoyed ten years afterwards, during his residence at the Cape of Good Hope, sufficed to convince him of the necessity of executing a re-delineation. This improved drawing, accompanied by a catalogue of the stars situated within the boundaries of the nebosity, as well as a general description, have been embodied in *The Results of Astronomical Observations made at the Cape of Good Hope during the Years 1834-38*, and published in 1847.

Other observers, as Derham, Godin, Fouchy, Mairan, Picard, Le Gentil, Messier, De Vico, Lassell, Mitchell, and Lamont, have given us the results of their observations on this interesting object. The earlier observations have little value, owing to the deficiency in optical power of the instruments used. As Sir John Herschel's publication embraces nearly every important point connected with the subject which was known at that time, and is founded upon the observations of so many years, made with excellent telescopes, under favorable circumstances, it will be the one principally referred to in this communication; his nomenclature also will be adhered to, as it possesses the advantage of being already well known.

For the purpose of obtaining a general knowledge of the region in which the great nebula of Orion is situated, I commenced my operations by making a cursory examination of about four square degrees of the heavens in the neighbourhood of θ Orionis.

This examination developed the more prominent features, and enabled me to fix upon a convenient scale for the intended drawing. A system of sweeps was then instituted after the following manner. The telescope, being clamped in declination, was carried forward until it preceded the utmost limits of the nebula. It was then fixed in right ascension, and the successive fields carefully examined as they passed in review by the diurnal movement of the heavens. The different degrees of intensity of the light were indicated by numbers. Thus, when the first nebulous appearance reached the middle of the field of view of the telescope, the time was noted by a sidereal chronometer, and the degree of light, representing the faintest perception of light, was recorded as 7. When an increase of light was discernible, the time was again noted, and the figure 6, indicating a confirmation, was recorded; this has been adopted generally for the outline of the nebulous district. 5 shows a yet further increase of light. In this way, the different portions included in a single sweep were examined, 1 indicating the strongest light, in the vicinity of the Trapezium.

When it was judged that the whole nebulosity had passed, the hour-angle and declination circles were read off, the declination-circle changed five minutes, and the examination of another parallel commenced. The results of these sweeps were then reduced to right ascension and declination by differentiating on θ^1 Orionis, and, being corrected for convergence, were finally transferred to a chart, and are embodied in the drawings which accompany this memoir.

These sweeps were extended from half a degree north of the star C Orionis to one degree south of the star ι , θ^1 being constantly referred to as the point of departure.

This general method, however, would not answer for delineating the more delicate and intricate portions; for this purpose, as well as for the accurate location of the stars, it became necessary to have recourse to the micrometer. With this instrument, such stars as appeared to be favorably situated were arranged in groups by an eye sketch. The star θ^1 being adopted in the first instance as a primary station, differences of right ascension and declination, or of position and distance, were measured: when the distances became excessive, new stations were occupied, taking care always to preserve the connection with the preceding point by repeated measures.

A catalogue of the stars thus differentiated accompanies the memoir. No attempt has been made to locate every star that was visible within the boundaries of the nebula, for the reason that no apparent advantage, at all adequate to the great expenditure of time and labor which it would have required, was to be expected.

In order to obtain a correct outline of the more important points in the figure of the nebula, the stars contained in the annexed catalogue were, in the first instance, laid down according to their observed differences of right ascension and declination. All such parts of the nebula in the vicinity of the Trapezium as presented definite outlines susceptible of being measured were referred to θ^1 . Guided by these points, the outline was drawn and filled in, after many repeated examinations of the object under different powers.

In the course of these examinations with different eye-pieces, I was struck with a remarkable diversity in the appearance of the Huygenian region. It seems, as we increase the power of our eye-piece, that the clouds or clusters into which this region

separates become less numerous, in a manner quite different from that which would result from viewing it under a greater angle merely. The clusters increase in magnitude, while they diminish in number. Sir John Herschel, when describing this portion, as seen at Slough with his twenty-foot reflector, compares its appearance to that of "a curdling liquid, or the mottling of the sun's disk, only the grain is much coarser and the intervals darker." To me it appears composed of several clusters of stars, the components being separately seen for a moment under favorable circumstances. This resolution I have noticed more particularly north of star No. 26, and likewise in the vicinity of No. 12 and No. 43; but where the nebula assumes a cirrous character, as in the Messierian branch, I can see nothing of the kind.

There is quite a remarkable feature of the subnebulous region, which I do not find has been noticed heretofore. It is that of radiation, spreading and shooting southward from the stars Nos. 45, 50, and 61, near its base. I have noticed this appearance only on clear nights, when the moon has been absent, but then, on several occasions, it was very decided, and forcibly reminded me of an active aurora borealis.

There is something of the same character belonging to the light on the preceding side of the Huygenian region, but not so delicate; it is there more abrupt.

The Messierian branch, although extremely well defined, and presenting a bold outline on the preceding side from star No. 80 to No. 61, yet thence to its junction with the brightest portion of the nebula it presents no certain outline on either side, but fades insensibly into the Proboscis Minor on the one side and into the subnebulous region on the other. I mention this more particularly, because Sir John Herschel's last drawing exhibits a

regular, well-defined outline all the way to its junction with the Huygenian region; in this particular, I see it more like his early drawing of 1824.

On the preceding side of the Huygenian region, there is a strongly marked boundary, reaching nearly the whole distance from its southern extremity to star No. 10. This boundary was confirmed to me on the night of the 17th of January, while the moon was shining brightly in the immediate neighbourhood of the nebula. On comparing the sketch which I then made of it with the ancient figures of Picard, Huygens, and Le Gentil, they appeared less objectionable than one would have supposed possible without such a trial.

The Nebula Oblongata, which lies entirely south of a line joining the stars No. 76 and No. 93, divides on the following side into two branches. One of these branches curves towards, and apparently terminates near, the star No. 93; the other inclines southward, and connects with the Proboscis Minor. In the preceding direction, it can be traced to a junction with the nebula encircling the star No. 60.

The stars Nos. 10, 12, 26, and 27 mark the present boundaries of the Huygenian region, on the preceding and following sides, very accurately. Provided they are not physically connected with the nebula, they will serve as excellent landmarks for future comparison in regard to any change of form or position, should it take place.

No. 10 is situated close on the preceding edge of this bright region, and is closely followed almost in the same parallel by No. 12, a star of the seventeenth magnitude, the latter being *within* the boundary.

No. 27 is, as nearly as it is possible to determine with our

telescope, on the very edge of the following side, at the bottom of the Sinus Magnus, and is pretty closely preceded by No. 26, of the seventeenth magnitude, within the bright part. I do not find that star No. 27 has been noticed before; but when once caught sight of, there will be no great difficulty in judging of its situation in regard to the nebula, as it may be steadily seen. No. 27 will bear illuminated wires.

There is a great diminution of light in the interior of the Trapezium, but no suspicion of a star.

The connection of the main body of the nebula with that portion which surrounds C^1 Orionis is traced by the north-preceding route. It is quite decided; the nebulous light condenses strongly about C^1 and C^2 ; indeed, the majority of the stars in this neighbourhood are nebulous. C^1 is closely double: this, I believe, has not been noticed before.

No. 68 is also to me a new double star, the distance less than a second. The light terminates abruptly on the following side of C^2 . The star No. 54, with its companion No. 52, of the thirteenth magnitude, are both enveloped by the nebula. I notice that, in Sir John Herschel's figure, the light does not reach either of these two stars.

There is nebulous light yet farther north; but as, at the time, I did not succeed in tracing the connection, I have not included it in my drawings; neither does the light of C Orionis connect on the following side with the extensive fields about No. 92.

South of the double star No. 91, which is situated near the termination of the Messierian branch, the light spreads in the south-preceding direction, maintaining the cirrous character of the branch. I was unable to satisfy myself how far it might be possible to trace it southward, but certainly beyond Iota. Soon after passing this star, it, however, becomes very faint.

The small star No. 69 I do not find to have been noticed. No. 34 is also, I think, a new addition; it follows No. 81 of Herschel's Cape Catalogue.

I do not find that No. 44 of the nineteenth magnitude has been seen before; it is situated in a brilliant district, and is a difficult object to keep steadily in view; it follows No. 41 at a distance of about six seconds; the direction of a line joining these two stars is towards α of the Trapezium.

Sir John Herschel's drawing shows the southern termination of the Huygenian region strongly preceding α , whereas I have repeatedly laid the micrometer-wire upon it, and have found it to be of the same right ascension as α . The difference of declination between this point and α is $161''$.

His star No. 75 is well seen, but No. 78, to which the same magnitude is given in his table, has not been seen steadily by me. Indeed, the observations on it at different times have been so contradictory, that I could only account for the discrepancies by supposing it to be a variable star of short period.

In respect to the evidence of change in this nebula, the following points seem to demand attention.

In the first place, the regular, graceful, and well-defined outlines, indicated in Sir John Herschel's figure, both of the Messierian branch and that from the Huygenian region, sweeping along north of the stars Nos. 45–50 and 61 of my catalogue, certainly do not exist at present; or, I should rather say, I have not been able to trace them with our telescope at times when I could distinctly see stars that had escaped his notice. The outline of the Messierian branch cannot be distinguished below the star No. 61, while the bright portion of the Huygenian region ter-

minates abruptly and roughly at No. 50, and the nebula immediately assumes a totally different and a milder character.

Again, on the preceding side of the Messierian branch, near No. 75 of my catalogue, I do not find so bold an indenture as he has given. It is in this neighbourhood only that I have found any difficulty in identifying his stars. I presume that I have here two new stars, but neither No. 75, nor the two next south of it, agrees in position with any of the stars in his catalogue.

The preceding side of the Huygenian region in his figure has the light gradually softened away into the "Regio Gentiliana." I here see a strong irregular outline, extending from the "Sinus Gentilii" to a little beyond No. 10.

The positions of the stars marked with an asterisk, in the annexed catalogue, were determined by alignment only, from stars in their neighbourhood which had been subjected to micrometrical measurement. This approximate method was considered sufficiently accurate in this case, as the stars in question were, from their situation, of minor importance in regard to the principal object which I had in view, namely, a true delineation of the nebula.

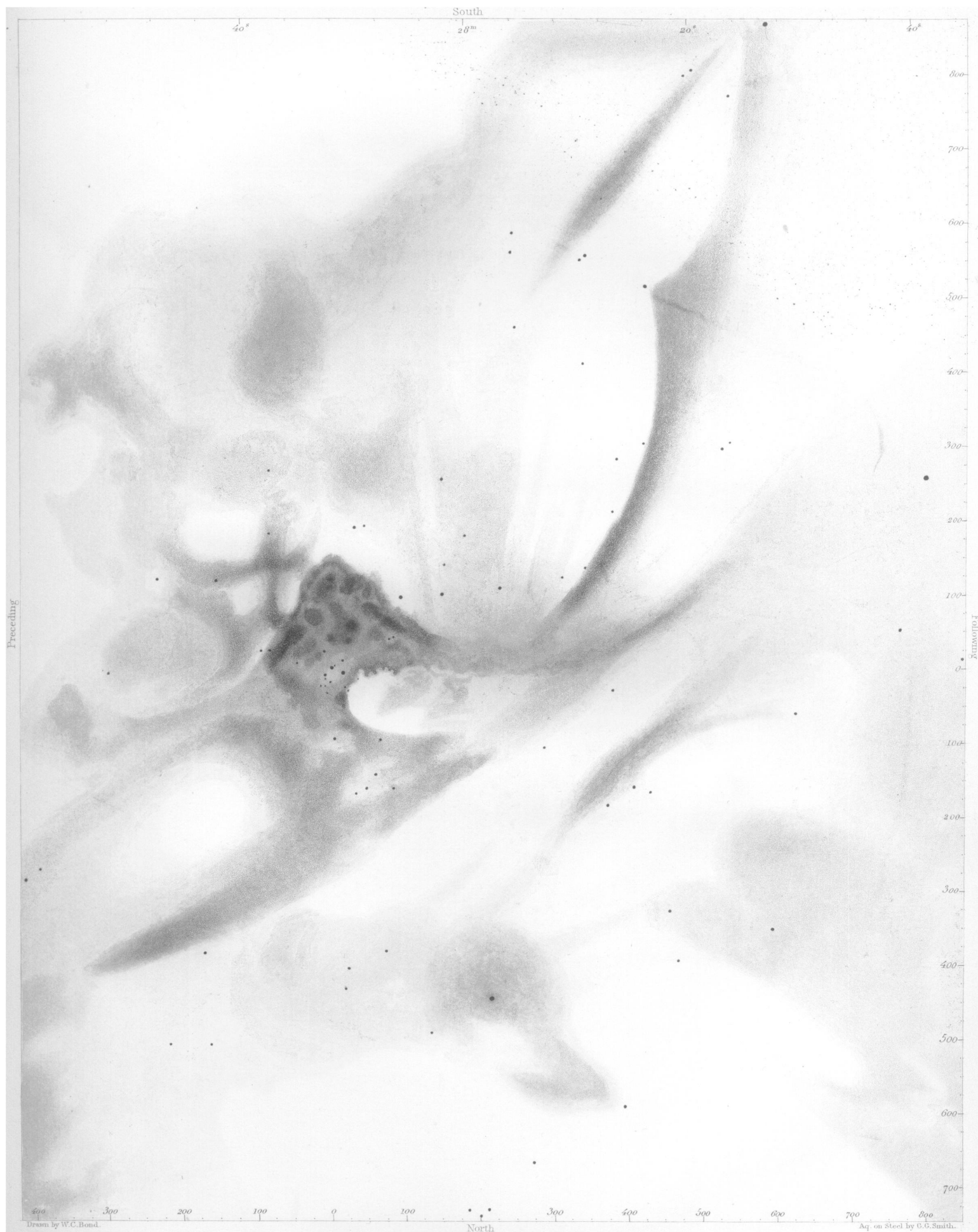
In this catalogue the stars are numbered in the order of their right ascensions, and are all referred, in seconds and decimals of seconds, of arc, to θ^1 (No. 22) of the Trapezium.

In the column headed x , — signifies that the star precedes, and + that it follows θ^1 , by so many seconds, measured in the direction of AR.

In the column headed y , + signifies that the star has greater, and — that it has less, north polar distance than θ^1 .

CATALOGUE OF STARS OBSERVED IN THE NEBULA ABOUT Θ ORIONIS.

No.	Mag.	x.	y.	No.	Mag.	x.	y.
1	11	— 499.3	— 289.4	49	13	+ 148.9	+ 251.8
2	14	— 463.5	+ 114.5	50	8	+ 150.5	+ 95.8
3	10	— 400.2	— 271.3	51	12	+ 150.9	+ 134.7
4	10	— 306.7	— 5.3	*52	13	+ 155.	— 1698.
5	11	— 242.3	+ 118.0	53	14	+ 156.3	— 1897.9
6	10	— 219.0	— 510.1	54	4	+ 171.0	+ 1869.9
7	11	— 173.4	— 385.2	55		+ 180.2	+ 175.4
8	12	— 164.1	— 513.0	56	15	+ 190.0	— 731.1
9	15	— 159.4	+ 120.1	57	8	+ 194.8	— 1747.4
10	17	— 101.0	+ 23.6	58	15	+ 200.0	— 736.0
11	18	— 90.2	+ 22.6	59	15	+ 208.0	— 730.2
12	17	— 88.0	+ 181.0	60	8	+ 215.6	— 446.4
13	9	— 87.1	+ 273.4	61	10	+ 227.3	+ 111.7
14	11	— 71.3	— 1897.6	62	8	+ 226.7	— 1985.4
15	18	— 52.0	+ 5.0	*63	11	+ 235.	+ 565.
*16	19	— 12.	— 22.	*64	11	+ 243.	+ 585.
17	7	— 9.3	— 8.4	65	12	+ 244.7	+ 464.0
18	18	— 7.0	+ 13.8	66	9	+ 277.4	— 669.9
*19	19	— 6.	— 19.	67	19	+ 285.2	— 109.0
*20	20	— 5.	— 27.	68	12	+ 304.6	— 2101.0
21	8	— 4.8	— 15.2	69	18	+ 308.8	+ 123.6
22	5	0.0	0.0	70	7	+ 320.4	— 1927.3
23	14	+ 5.1	— 98.0	71	12	+ 335.1	+ 411.3
*24	18	+ 9.	+ 8.	72	12	+ 338.2	+ 557.6
25	7	+ 12.6	— 6.1	73	17	+ 340.2	+ 135.4
26	17	+ 15.7	— 25.5	74	10	+ 340.2	+ 560.6
27	18	+ 17.2	— 27.5	75	17	+ 375.4	+ 213.3
28	14	+ 20.5	— 433.0	76	10	+ 373.3	— 195.3
29	13	+ 26.3	— 407.5	77		+ 378.3	— 66.3
30	17	+ 27.5	+ 190.2	78	18	+ 385.4	+ 282.6
*31	19	+ 29.	— 11.	79	9	+ 405.0	— 596.0
32	17	+ 30.3	— 169.7	80	12	+ 423.8	+ 523.8
33	15	+ 35.7	— 160.4	81	14	+ 461.6	+ 793.8
34	18	+ 37.3	+ 192.3	82	12	+ 465.0	— 391.7
35	13	+ 48.1	— 1806.9	83	17	+ 455.9	— 331.4
36	10	+ 48.5	— 1894.4	84	14	+ 475.4	+ 799.8
37	15	+ 55.8	— 147.3	85	12	+ 424.4	— 168.6
38	12	+ 61.0	— 675.2	86	16	+ 414.7	+ 306.8
39	14	+ 62.1	— 98.8	87	12	+ 520.4	+ 302.8
40	7	+ 72.6	— 1989.0	*88	16	+ 527.	+ 771.
41	17	+ 73.5	+ 36.8	*89	18	+ 531.	+ 307.
42		+ 75.5	— 383.9	*90	11	+ 547.	— 2126.
43	18	+ 76.5	+ 38.0	91	8	+ 581.3	+ 876.3
*44	19	+ 80.	+ 40.	92	15	+ 596.6	— 355.8
45	6	+ 97.5	+ 94.4	93	10	+ 630.2	— 58.8
46	11	+ 125.9	— 2152.8	94	13	+ 800.3	+ 258.4
47	9	+ 140.5	— 494.7	95	9	+ 1061.8	+ 56.8
48	10	+ 143.7	— 614.1	96	13	+ 1136.4	+ 9.0



THE NEBULA SURROUNDING THE STAR THETA ORIONIS.
As seen with the Twenty three feet Refractor at Cambridge U.S. 1848.